CLAIMS

What is claimed is:

1. A method for estimating the topological dimension of a set of data points representing a nonlinear system response, each data point having the same number of coordinates, the method comprising the steps of:

identifying a maximal set of non-redundant, nonlinear single-constraint fits to data points which are in the neighborhood of a predetermined base point, in which the gradient of each fit in the neighborhood of the base point identifies a constrained direction;

estimating the number of constraints in the neighborhood of the base point to be the same as the number of such constrained directions that are linearly independent;

estimating the topological dimension of the set of data points to be the original number of coordinates of the data minus the estimated number of constraints;

wherein the step of identifying a set of fits further comprises the step of:

using a matrix decomposition technique to find singular values and singular vectors, or eigenvalues and eigenvectors, of a design matrix formed from basis functions constructed from the data values; and

wherein each fit is a linear combination of a set of basis functions for which the zero-contours of the fit, that is, the curves at which the fit has the value zero, pass near the data points and a set of individual coefficients multiplying the individual basis functions, wherein the coefficients of the basis functions are the components of singular vectors obtained from a decomposition of the design matrix.

2. A method as in claim 1 wherein the step of identifying the number of constraints further comprises the step of:

attenuating fits that have near-zero gradients at the base point.

3. A method as in claim 1 wherein the matrix decomposition technique is a singular value decomposition of the matrix.

4. A method as in claim 1 wherein the matrix decomposition technique is an eigenvector decomposition of the matrix product of the transpose of the matrix and the matrix itself.

5. A method as in claim 1 wherein the step of estimating the number of constraints additionally comprises the step of:

weighting the gradients by a weighting factor which depends upon an uncertainty level in the data points, to effectively retain only statistically significant gradient terms.

6. A method as in claim 1 wherein the step of estimating the number of constraints additionally comprises the step of:

weighting the gradients by a weighting factor which depends both upon an uncertainty level in the data points and the number of independent basis functions, to effectively retain only statistically significant gradient terms.

7. A method as in claim 1 wherein the estimated number of constraints is reduced by excluding directions that are assumed to be unconstrained.

8. A method as in claim 10 wherein data points near or at the base point may be filtered or projected in such a way as to satisfy the constraints.

9. A method for estimating the topological dimension of a set of data points representing a nonlinear system response, each data point having the same number of coordinates, the method comprising the steps of:

identifying a maximal set of non-redundant, nonlinear single-constraint fits to data points which are in the neighborhood of a predetermined base point, in which the gradient of each fit in the neighborhood of the base point identifies a constrained direction;

estimating the number of constraints in the neighborhood of the base point to be the same as the number of such constrained directions that are linearly independent;

estimating the topological dimension of the set of data points to be the original number of coordinates of the data minus the estimated number of constraints

wherein each direction that is assumed to be unconstrained may be weighted by a factor which reflects a confidence level in the assumption.

10. A method as in claim 9 wherein the step of identifying the number of constraints further comprises the step of:

attenuating fits that have near-zero gradients at the base point.

11. A method as in claim 9 additionally comprising the step of:

identifying constraints that could have arisen for noisy data points if true underlying values of the data points had been mis-measured slightly by an amount consistent with an assumed level of noise in the data.

12. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:

weighting the gradients by a weighting factor which depends upon an uncertainty level in the data points, to effectively retain only statistically significant gradient terms.

13. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:

weighting the gradients by a weighting factor which depends upon the number of independent basis functions allowed for the fits.

14. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:

weighting the gradients by a weighting factor which depends both upon an uncertainty level in the data points and the number of independent basis functions, to effectively retain only statistically significant gradient terms.

15. A method as in claim 9 wherein the estimated number of constraints is reduced by excluding directions that are assumed to be unconstrained.

16. A method as in claim 9 wherein the assumed level of noise may be different for each data point.

17. A method as in claim 9 wherein data points near or at the base point may be filtered or projected in such a way as to satisfy the constraints.